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Short Communication: Genetic variability of local corn cultivars from Kisar Island, Maluku, Indonesia based on morphological characters

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Abstract. *Sinay H, Karuwal RL. 2018. Short Communication: Genetic variability of local corn cultivars from Kisar Island, Maluku, Indonesia based on morphological characters. Biodiversitas 19: 2302-2307.* The purpose of this research is to know the relationship of local corn cultivars derived from Kisar Island based on the morphological characterization. The research was conducted in Kisar Island, Southwest Maluku District, Maluku Province, Indonesia. The morphological characterization was performed on 5 stem characters, 14 leaf characters, 15 male flower characters, 2 female flower characters, 12 cob characters, and 12 seed characters. The description was conducted using the corn descriptor guide by CIMMYT, IBPGR, UPOV, and *Departemen Pertanian Republik Indonesia*. Color standardization was conducted following standard color charts from the Royal Horticultural Society Color Chart. The data was described and scored based on the appearance of each plant organ observed in the field relative to the descriptor guide. The scoring results were then standardized into 0/1 binary data, which were then analyzed by NTSYS program used for dendrogram construction. Cluster analysis shows that there are two main groups of corn cultivars. The first group consists of *merah delima tongkol cokelat*, *merah darah*, *putih*, *kuning genjah*, and *merah delima tongkol putih*. The second group consists of *kuning dalam* and *pulut* cultivars.

Keywords: Genetic variability, corn, morphological characters

INTRODUCTION

Corn is the world's most multipurpose crop. It becomes one of a staple food for hundreds of million people in the developing countries (Smith et al. 2017). It has a large genetic diversity caused by cross-pollinated traits (Azad et al. 2012). According to Iriany et al. (2008), nowadays, corn varieties is estimated about 50.000 varieties consisting of local varieties and improved varieties resulted from breeding results. In Indonesia, the genetic diversity of corn is the highest in Asia (Syafi'i et al. 2015), because many local corn cultivars with different characteristics had been found in many parts of Indonesia. Differential characteristic is because of the genetic composition of local population, and the process of genotype isolation which undergoes the changes and adaptation of plant species to specific agro-climates (Sork et al. 2010) such as the diversity of geographical conditions, and the magnitude of climate change as well as soil conditions between one region and another (Wijayanto 2007).

Southwest Maluku District is one of the area in Maluku, Indonesia with high diversity of corn germplasm (Pesireron et al. 2013a). In this area, corn was already been cultivated as the main commodity in every cultivation activity in all growing seasons (Pesireron et al. 2013a). Previously, the exploration and documentation of corn germplasm has been done by Alfons et al. (2003) who found that in Kisar Islands of Southwest Maluku District, seven local corn cultivars are being specific cultivars to this location, namely *merah delima tongkol cokelat, merah delima tongkol putih, merah darah, kuning genjah, kuning dalam, pulut*, and *putih*. The most striking feature of these local cultivars is the color variation in their seeds. It is predicted that these local cultivars had an ability to adapt to local environmental conditions.

The existence of local cultivars with distinctive characteristics, and high adaptability is the germplasm source that must be preserved, and this specific characteristic can be utilized for assembling superior varieties. Arunga et al. (2015) state that germplasm is a source of genes that can be utilized to increase plant diversity, so that an opportunity to improve the character of a population and to form new varieties can be obtained. Previously, Pabendon et al. (2003) suggest that the diversity of germplasm and the relationship between breeding materials is very important to be known and understood. It is useful in crossover planning to produce hybrids and the formation of better hybrids. In addition, the high local genetic diversity of corn can be also utilized to reduce the need for hybrid corn obtained from multinational corporations which rarely concern to use local cultivars (Westengen et al. 2014).

Research on genetic diversity can be done by utilizing a genetic marker system of both morphological markers, as well as molecular markers (Farooq and Azam 2002; Bhat et al. 2010). The morphological marker is a very traditional system and has been used for a long time. This marker identifies plant characteristics based on visible traits or characteristics. A number of parameters such as plant height, shape, and size of flowers, leaves, fruits or seeds,

are observed and scored.

Research on the genetic diversity of corn based on morphological characterization in Indonesia has been reported by Wijayanto (2007), Febriani et al. (2008), Amzeri et al. (2011), as well as by Yusran and Maemunah (2011), while the combination of morphological and molecular characters has been reported by Pabendon et al. (2007), Pabendon et al. (2008), and Andi Takdir et al. (2009). Research on morphological performances of corn from Southwest Maluku District have been also reported by Pesireron et al. (2013a), as well as in Leti and *Pulau-Pulau Terselatan* (Pesireron et al. 2013b). However, the results of clustering in dendrogram only showed the position or close relationship between local corn cultivars, by exploring the morphological appearance of corn cultivars found in their research area. Although research on the genetic diversity of corn in Indonesia using morphological markers has been widely reported, corn cultivars from Kisar Island in South West Maluku District have not been reported, yet. Therefore, the purpose of this research was to know morphological characters and genetic variation of corn cultivar from Kisar Island South West Maluku District based on morphological characterization.

MATERIALS AND METHODS

Procedures

Corn planting was done in Kisar Island, Southwest Maluku District, Maluku Province, Indonesia during April to August 2014. Cultivars used were local cultivars obtained from Farmer in Kisar consisting of seven local cultivars, i.e., *merah delima tongkol cokelat, merah delima tongkol putih, merah darah, kuning genjah, kuning dalam, pulut*, and *putih*. As a comparison (outgroup) of corn on Kisar Island, three hybrids of corn varieties were obtained from Research Institute for Cereals in Maros, South Sulawesi, namely *srikandi*, *lamuru*, and *anoman* varieties.

For the morphological characterization, the cultivars were sown in the field and the characterization was done following descriptors proposed by El Centro International de Mejoramiento del Maiz del Trigo / The International Maize and Wheat Improvement Center and The International Board for Plant Genetic Resources (CIMMYT and IBPGR 1991), International Union For The Protection of New Varieties of Plants (UPOV 2009) and *Departemen Pertanian Republik Indonesia* (2004). The descriptor guide consists of 60 characters including qualitative characters (color, shape, direction) and quantitative characters (height, diameter, distance, length, width, amount, and thickness) of stem, leaf, flower, fruit, and seed. For color standardization, standard color charts from the Royal Horticultural Society Color Chart were used.

Data analysis

The data of morphological characterization were described according to the appearance of each plant organ observed in the field, and was scored following the descriptor guide with some modifications. The scoring results were then standardized to be 0/1 binary data, analyzed by NTSYS program and used for dendrogram construction to analyze the genetic diversity of maize based on morphological characters.

RESULTS AND DISCUSSION

Kisar Island is one of the islands in the South West Maluku District which is known as the main area of corn production in Maluku. In the strategic plan of corn development in Maluku, this area becomes the first zone where people use corn as the staple food, and always planted in dry climates (Susanto and Sirappa 2005) and very low rainfall. Alfons et al. (2003) has explored and documented the corn germplasm in Kisar Island and found that in this Island, there are seven local corn cultivars that are specific to this island, namely *merah delima tongkol cokelat, merah delima tongkol putih, merah darah, kuning genjah, kuning dalam, pulut*, and *putih.* Like common corn, corn in Kisar island belongs to family Poaceae and genus Zea, but the most striking features of these cultivars is the variation of their color of the seed.

Morphological observation of the characters of the vegetative and generative organ showed that there was some variation in the color of stem (Figure 1). It can be observed from the stem color showing reddish to brown in *merah darah*, *merah delima tongkol cokelat*, and *merah delima tongkol putih*, while other local cultivars look green on their stem color.

The variation of leaf organ could also be found in these local cultivars especially in the edges shapes of ligule. One cultivar showed wrinkled edges shape and another one was slippery (Figure 2). Other variation also can be seen such as presence of feathers on the midrib, leaf strands direction, and the number of leaves.

For the generative organs, morphological variation was also observed in the color of male and female flower. The male flower was red until brown (Figure 3), while female flower was red, brown, and black (Figure 4). Morphological character could also be seen on the fruit especially the seed color, fruit shape and size which were the main character of corn in Kisar Island (Figure 5).

The result of morphological characterization based on five characters of stem, fourteen characters of leaf, fifteen characters of male flower, two characters of female flower, twelve characters of cob and twelve characters of seed varied. Based on these morphological data, dendrogram construction of these cultivars was done after standardization into binary data and dendrogram construction using NTSYS program as shown in Figure 6.

Overall, the dendrogram shows that there were two main groups formed. Group one consists of *merah delima tongkol cokelat* (MDTC), *merah darah* (MD), *kuning genjah* (*KG*), *putih* (PTH), and *merah delima tongkol putih* (MDTP) cultivars, while the second group consists of *pulut* (PLT) and *kuning dalam* (KD) cultivars. This result explained that the grouping not only based on the similarity in grains color, but the similarity in other morphological characteristics that enable one cultivar to belong to a group, although it has different grains color or other morphological traits.

Figure 1. Variation in stem color of local corn cultivars in Kisar Island. A. Reddish, B. Green

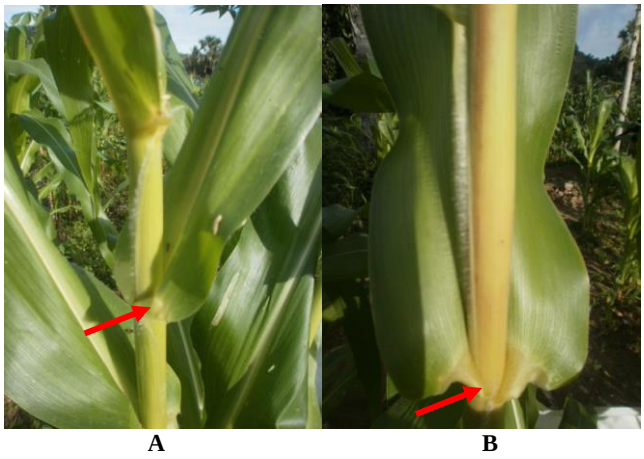

Figure 2. Variation in edges shape of ligule of some local corn cultivars in Kisar Island. A. Slipper, B. Wrinkled

Figure 3. The color variation of male flower

Figure 4. The color variation of female flower

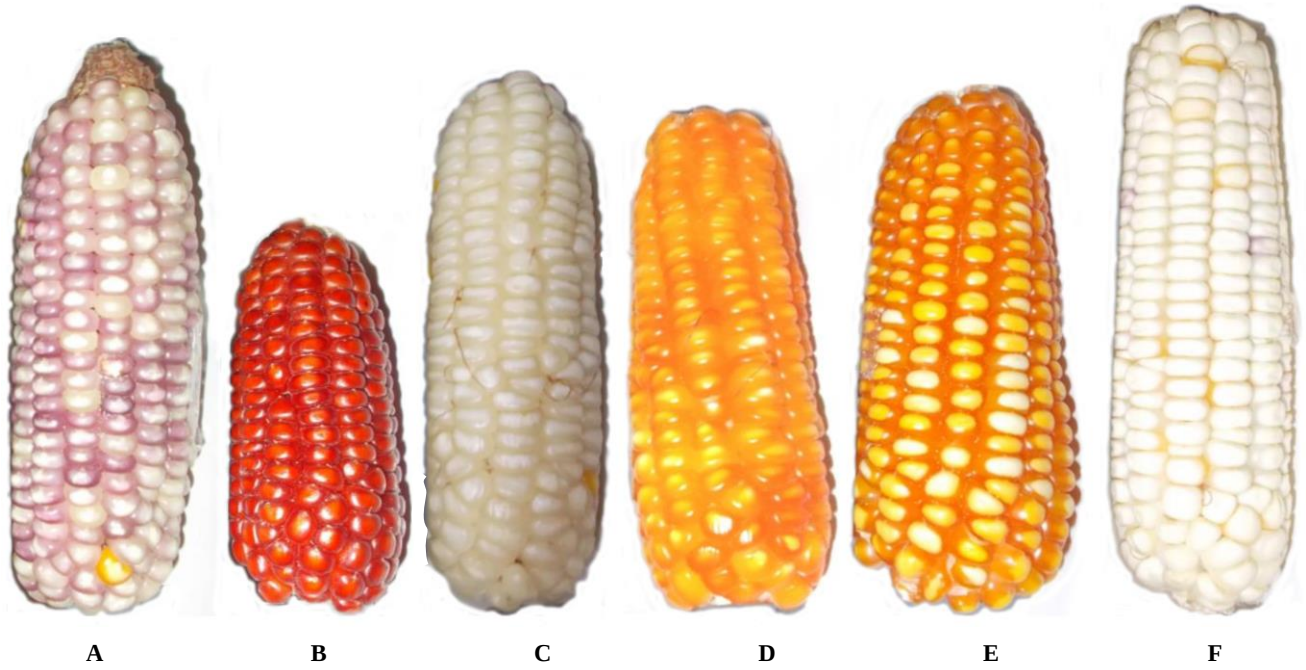

Figure 5. Variation of seed color, fruit shape and size of local corn cultivars from Kisar Island, Southwest Maluku District, Maluku Province, Indonesia. A. *Merah delima*, B. *Merah darah*, C. *Pulut*, D. *Kuning genjah*, E. *Kuning dalam*, F. *Putih*

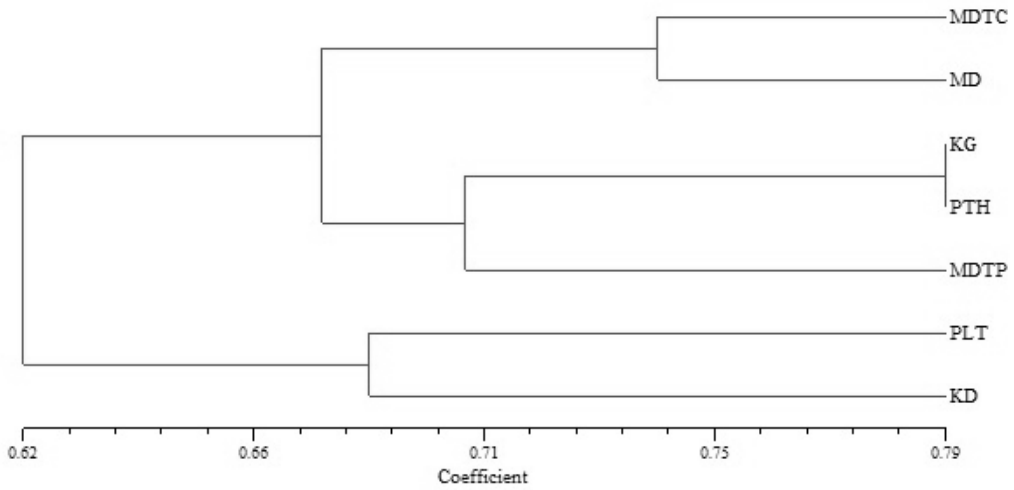

Figure 6. Result of dendrogram construction based on morphological characters of seven local corn cultivars from Kisar Island, Southwest Maluku District, Maluku Province, Indonesia. Note: MDTC: *merah delima tongkol cokelat*, MD: *merah darah*, KG: *kuning genjah*, PTH: *putih*, MDTP: *merah delima tongkol putih*, PLT: *pulut*, KD: *kuning dalam*

Many morphological characteristics were observed, such as stem, leaf, flower, and grains in quantitative nor qualitative characters. This result could be used as the basic principle to classify or group the local corn cultivars of Kisar island. Jose et al. (2005) said that the more morphological character's similarities were observed, the more genotype will agglomerate into the same group. On the other hand, the lower morphological characters similarities were observed, the more genotype will be clustered in different group.

Based on the environmental condition, the cultivars observed on this research were local cultivars planted in the same location, under the same environmental condition and in the same season. However, in every cultivar of those seven cultivars shows a diversity of morphology among each other. This supported by Jose et al. (2005) who reported that the genotype could possibly come from the same area, but it did not always have to be in the same group.

For the diversity of morphological characteristics of each cultivar, it shows that even though those cultivars planted under the same environmental condition, but each cultivar had different way of adaptation toward the environmental condition. Iriany et al. (2008) said that the diversity of local corn cultivars was formed by the process of genotype isolation, which could be changed and be adapted toward specific condition.

The diversity of morphological characteristics of corn planted in the same conditions may occur, due to the genetical factor, because the differences of genetical sequences are one factor that causes the diversity of plant. This assumption is based on what has been proposed by López-Caamal and Tovar-Sánchez (2014) that genetically different cultivar which is planted in the same condition, could give a diversity in morphological characteristics.

This diversity of morphological characters could possibly influence by many factors, i.e., the environment and the genetical factor. Huang et al. (2016) reported that the variation of phenotypic appearance of plant could be caused by the difference in the plant inside character (genetic), difference in environmental condition, nor the interaction of both factors.

In line with the adaptation ability of each cultivar toward environmental condition, the other result also reported that *kuning dalam* cultivar disposed to be different with other cultivars in the osmolit content, such as prolin, and also by the growth production aspect (Sinay and Karuwal 2014: and Sinay et al. 2015). This result was then confirmed by the result of grouping based on microsatellite genetic marker on the same cultivars as well as reported by Sinay and Karuwal (2017) that apparently the result were relevant to the morphological grouping result of this research. *merah delima tongkol cokelat*, *merah delima tongkol putih*, *merah darah*, and *kuning genjah* cultivars disposed to be in the same main group, although it was then dispersed into small sub-group, while *kuning dalam* cultivar disposed to separate or in other groups. This shows that the result of molecular test propose and relevant to the morphological result. Moreover, it can be stated that the morphological diversity happened because of the diversity of genetical composition.

In conclusion, based on the result of the research, it can be concluded that: (i) Local corn cultivar from Southwest Maluku District has morphological diversity both vegetative or reproductive organ. (ii) Morphological characterization resulted in grouping of local corn cultivars into two main groups with a similar coefficient of 0.62-0.79.

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